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Three-Dimensional Modeling of Wellbore Stability Parameters in the Sarvak Reservoir of One of the Southwest Iranian Fields

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Extended Abstract: During drilling and development of a field, the rock mechanical properties and stress state have a great impact on the drilling bit selection, optimization of the drilling path, casing design and the safe mud weight window determination. Using the geomechanical model of the wells, a safe mud weight window can be estimated, which saves time and cost of future drilling. In this study, 1D geomechanical models were constructed for 30 wells in Sarvak Formation, in one of the south-western Iranian oil fields. Breakout and breakdown pressures were calculated using Mohr–Coulomb and Mogi-Coulomb methods. The wellbore stability parameters (including pore pressure, minimum horizontal stress, breakout pressure and breakdown pressure) were modeled three-dimensionally using geostatistical techniques (i.e. Kriging and Sequential Gaussian Simulation). In the lower part of Sarvak Formation, the breakdown pressure is low and the breakout pressure is high, so the safe mud weight window is very narrow. To verify 3D models, cross plots of a well, which was not used in 3D modeling, and the 3D model (in that well location) were considered. The correlation coefficient for the pore pressure, minimum horizontal stress, breakout pressure and breakdown pressure were 0.83, 0.9, 0.78 and 0.74, respectively. The 3D models are applicable in the future drilling program. Also, these models can be used for the hydraulic fracturing plan and reservoir management.

Keywords: Wellbore Stability, Stress, 3D modeling, Sarvak Formation

Summary: Geomechanical modeling has an incredible impact on decreasing the coasts of drilling operation. In this study, 1D geomechanical and wellbore stability models were constructed for 30 wells of the studied oil field. In this section elastic modulus, pore pressure, principal horizontal stresses, breakout pressure and breakdown pressure were calculated. Then, breakout pressure and breakdown pressure were modeled three-dimensionally using Kriging and Sequential Gaussian Simulation (SGS) methods. It was concluded that the Mohr–Coulomb method calculates higher breakout and breakdown pressures than the Mogi-Coulomb method. The trend of Kriging and SGS models are fairly similar, but SGS method is more capable to show the heterogeneity. In the Sar-Intra zone, the breakout pressure is high and the breakdown pressure is low, so the safe drilling mud weight window for this zone very is narrow.

Introduction: The wellbore stability problems impose heavy costs on the world oil industry annually. Wellbore instability happens in two main ways: 1) excessive breakouts creation, 2) induced fractures creation (caused by high weight drilling mud). The geomechanical model is the basis for assessing the stability of the wells. By having a 1D geomechanical model, safe mud weight window can be estimated. Determination of safe mud weight window saves time and decreases drilling cost.

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Methodology and Approaches: In this study, Eaton's method and poroelastic equations were used to estimate the horizontal stresses, respectively. The dynamic elastic modulus was calculated using V_P, V_S and density logs. Then, using rock mechanical data, the dynamic data converted to the static ones. Breakout and breakdown pressures were calculated using Mohr–Coulomb and Mogi-Coulomb methods. Three-dimensional models of wellbore stability parameters were constructed using Kriging and Sequential Gaussian Simulation (SGS) methods. For 1D and 3D modeling, Geolog and Petrel softwares were used, respectively.

Results and Conclusions: In this study, breakout and breakdown pressures were calculated using Mohr–Coulomb and Mogi-Coulomb methods for 30 wells. Then these parameters were modeled using Kriging and SGS methods in a three-dimensionally. The Mohr–Coulomb method calculates higher breakout and breakdown values than the Mogi-Coulomb method. The data trend of Kriging and SGS methods are compatible, but SGS method is more capable to show the heterogeneity and minor data variations. In the Sar-Intra zone, the breakout pressure is high and the breakdown pressure is low, so the safe drilling mud weight window is very narrow.